Feb. 17, 1942. E. STUMP 2,273,296

APPARATUS AND PROCESS FOR SEPARATING AND CLEANING MATERIALS

Filed Jan. 31, 1938 4 Sheets-Sheet 1

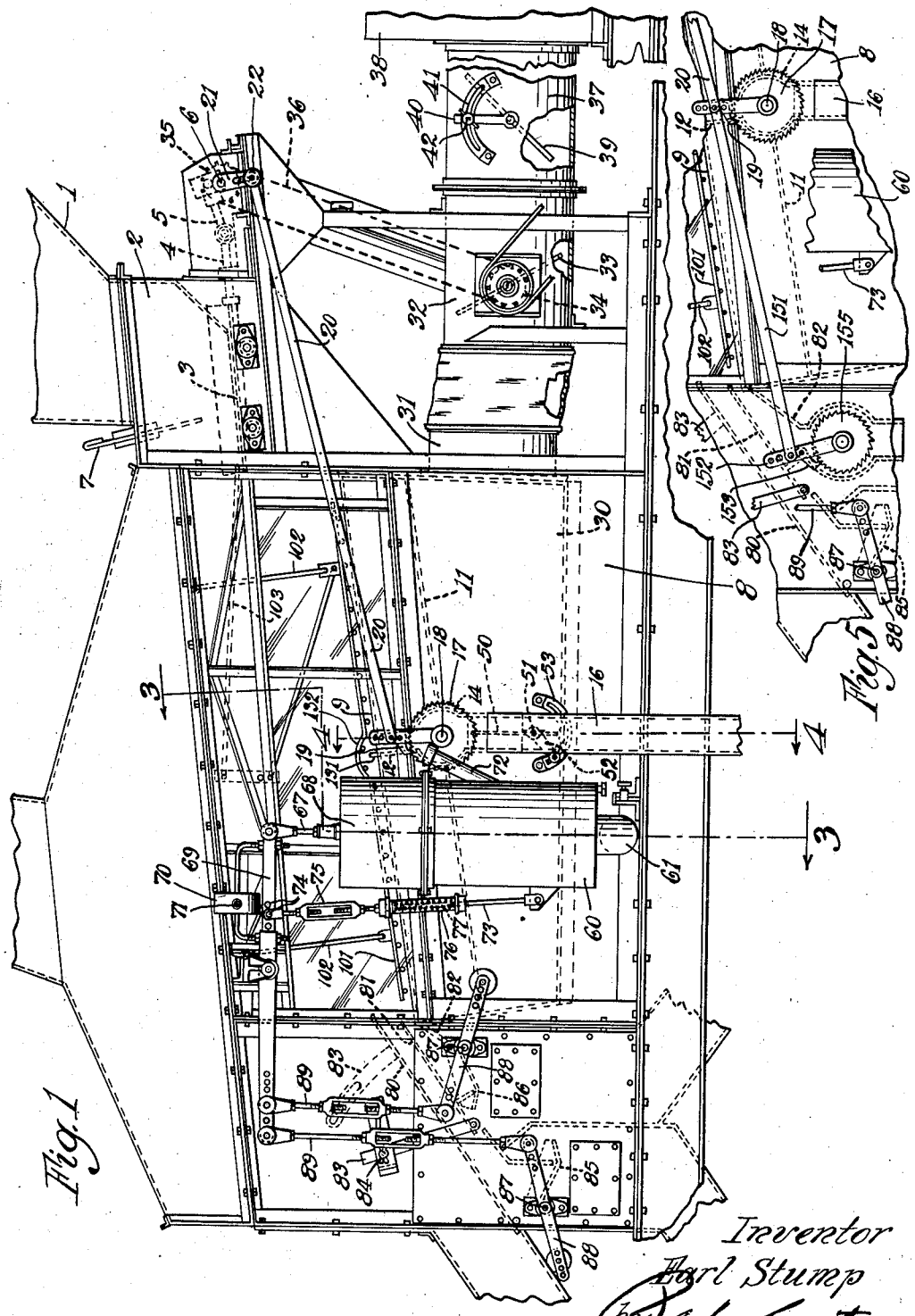


Fig. 1

Fig. 5

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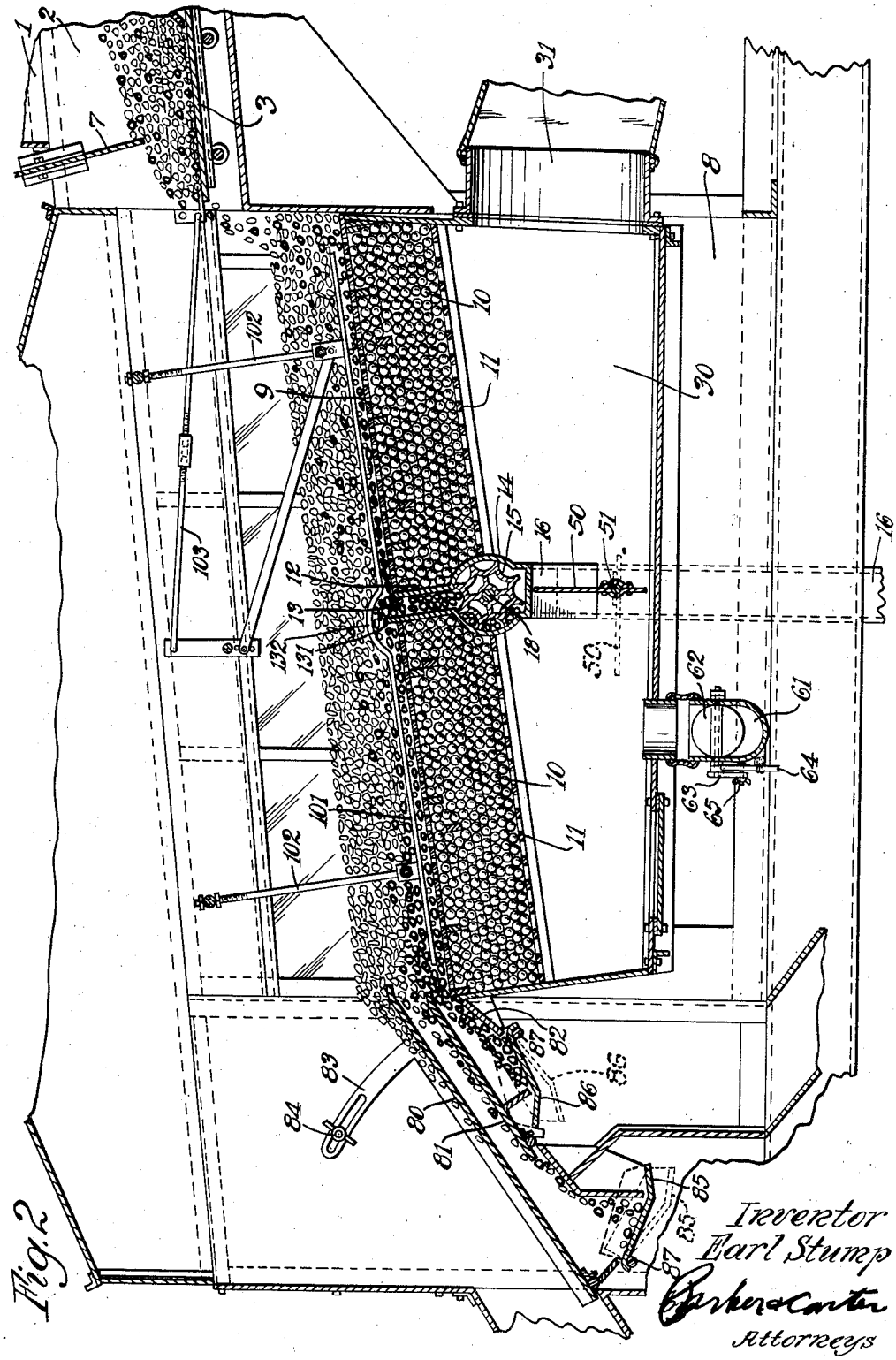


Fig. 2

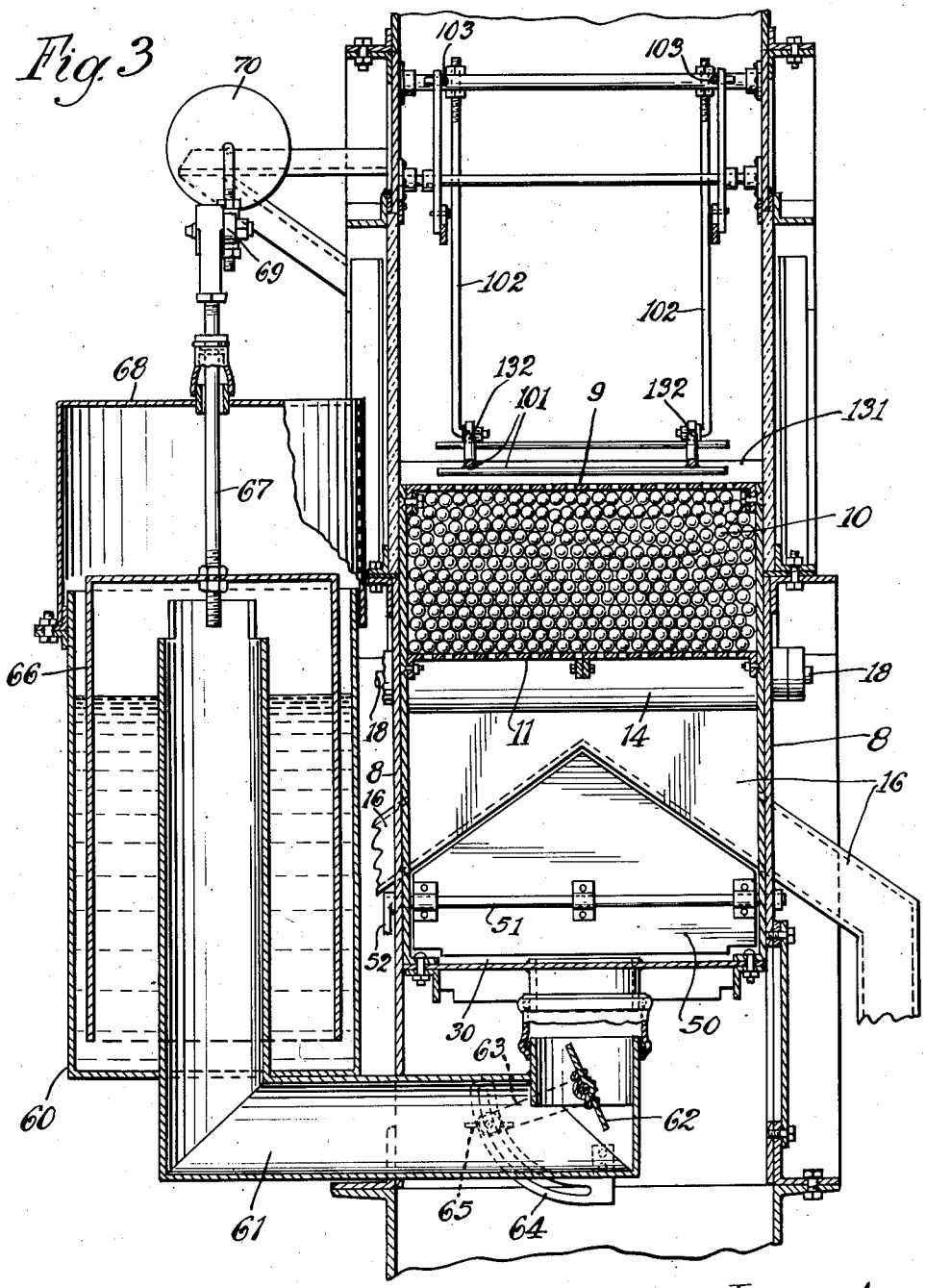
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APPARATUS AND PROCESS FOR SEPARATING AND CLEANING MATERIALS

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Fig. 3



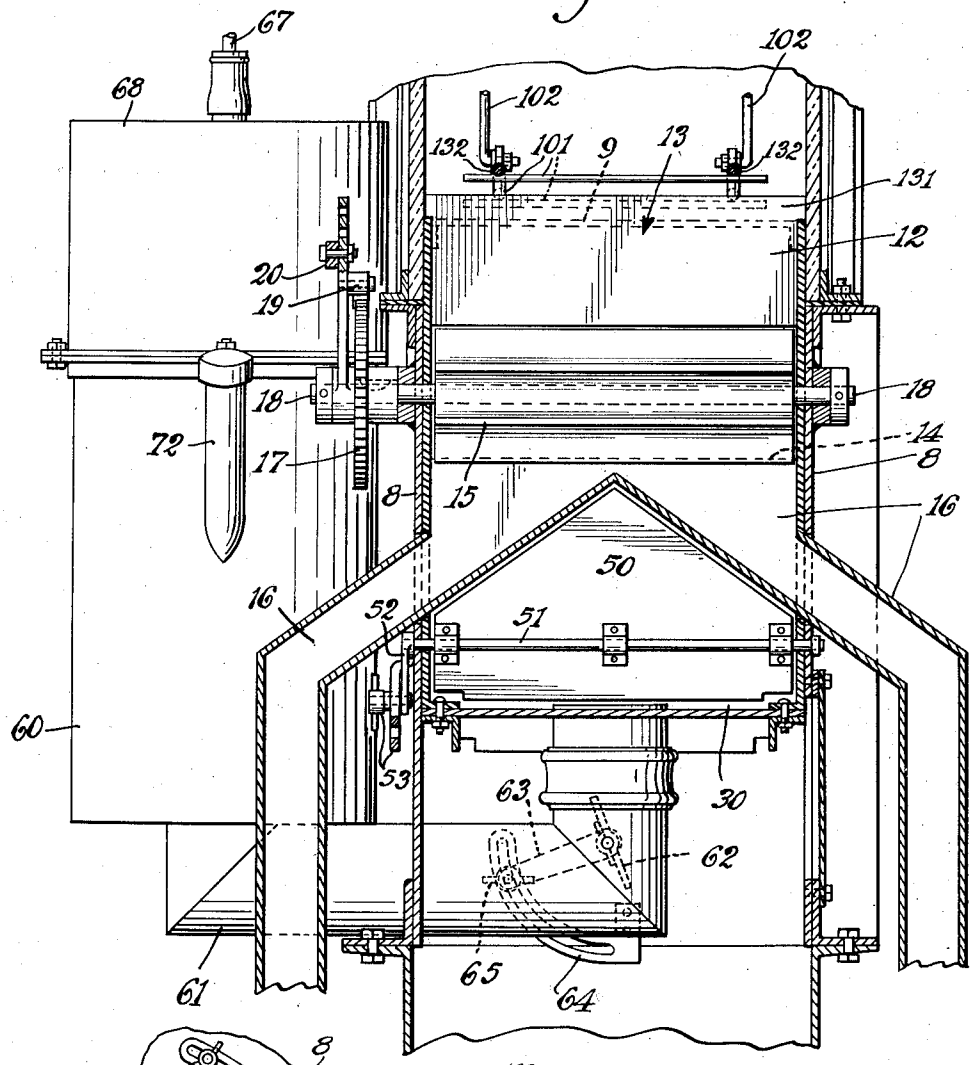
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APPARATUS AND PROCESS FOR SEPARATING AND CLEANING MATERIALS

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Fig. 4



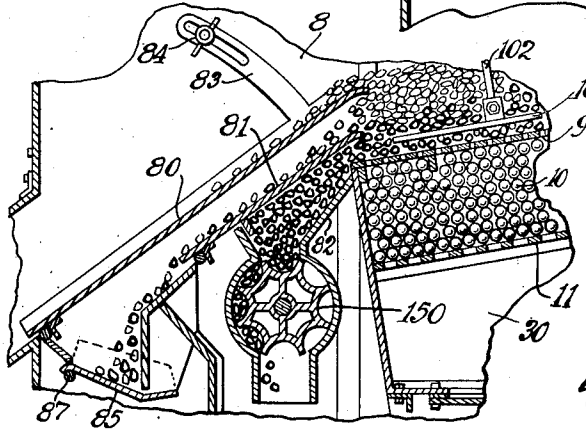


Fig. 6

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Patented Feb. 17, 1942

2,273,296

UNITED STATES PATENT OFFICE

2,273,296

APPARATUS AND PROCESS FOR SEPARATING AND CLEANING MATERIALS

Earl Stump, Chicago, Ill., assignor to Roberts and Schaefer Company, Chicago, Ill., a corporation of Illinois

Application January 31, 1938, Serial No. 187,843

7 Claims. (Cl. 209—475)

My invention relates to apparatus for gravitation separating particles of different specific gravities, and while especially applicable to and useful in connection with the cleaning of coal by air, it may be used equally well for separating other material both by the use of air, or other fluid separating or floating media.

One object of my invention is to provide a machine which can be applied to the separation of fragmentary material in one operation through a comparatively wide range of sizes, thereby dispensing with excessive preliminary screening.

Other objects will appear from time to time throughout the specification and claims.

My invention is illustrated more or less diagrammatically in the accompanying drawings, wherein—

Figure 1 is a side elevation of the device;

Figure 2 is a longitudinal section on an enlarged scale of the device shown in Figure 1;

Figure 3 is a section along the line 3—3 of Figure 1;

Figure 4 is a section along the line 4—4 of Figure 1;

Figure 5 is a view similar to Figure 1 showing a modified form;

Figure 6 is a section similar to Figure 2 showing a modified form.

Like parts are indicated by like characters throughout the specification and drawings.

As above stated, my invention may be used for the treatment of other materials than coal and gases other than air may be used. For the sake of convenience, I have used in specification and claims the words referring specifically to coal and the refuse found therein and to air but it will be understood that these terms are used in a broad general sense and intended as equivalents to any kind of refuse and raw material and any kind of gas.

1 is a hopper adapted to receive and contain coal. 2 is a feed box. 3 is a reciprocating feed plate driven by a push rod 4, a connecting rod 5, a crank 6. 7 is a manually adjustable gate to assist in controlling the rate of feed of the coal. 8 is a housing containing a downwardly inclined air pervious deck 9, an internal resistance bed 10, in this instance comprising a pack of marble held together under pressure against the underside of the deck 9 by a pervious bottom plate 11. This marble pack is divided intermediate its ends by a generally vertical chute 12 which is coextensive with a discharge port 13 which extends clear across the deck 9 intermediate its ends. The lower end of the chute terminates in a cylindrical chamber 14 in which rotates a star or pocket wheel 15. This wheel discharges into a breeches chute 16, discharging outwardly on both sides from the housing 8. 17 is a ratchet wheel on the shaft 18, which carries the star wheel 15. 19 is a ratchet, 20 a connecting rod adapted to operate the ratchet and pivoted on a crank arm 21 on the crank shaft 6. The pivot is adjustable radially by means of the hand wheel 22. The star wheel will rotate when the feeder 3 reciprocates and the rate of rotation of the star wheel with respect to the reciprocation of the feeder plate will depend upon the radius about which the free end of the ratchet connecting rod rotates.

Beneath the resistance bed is a plenum chamber 30, adapted to receive a pulsating current of air under pressure through the conduit 31 from the pulsator housing 32. In this pulsator housing is a butterfly or pulsator valve 33 connected by means of sprockets 34, 35 and chain 36 to the feeder crank shaft 6. When the butterfly valve is perpendicular to the axis of the pulsator housing 32, air is largely cut off. When the pulsator valve is horizontal a free flow is permitted. A rapid rotation of this pulsator causes the air which is received under pressure through the conduit 37 from the blower 38 to be fed in a pulsating stream to the plenum chamber and so to be forced upwardly through the resistance bed, the pervious deck and the stream of material to be separated in a pulsating stream. 39 is a butterfly valve in the conduit 37 provided with an adjustable lever 40, quadrant 41, and thumb screw 42 whereby the total volume of air admitted to the system may be controlled.

The breeches chute 16 to some extent constricts the cross sectional area of the plenum chamber 30 intermediate its two ends. 50 is a valve plate which is in line with the breeches chute 16. It is pivoted on the shaft 51, which extends out through the wall of the housing. 52 is an adjusting arm on the shaft 51 associated with the quadrant and lock nut 53 whereby the operator may manually adjust the position of the valve flap 50 to control the rate of flow from the intake end of the plenum chamber to the discharge end.

60 is a water box on the side of the housing. 61 in an air pipe extending up inside said box above the level of the water contained therein and communicating with the plenum chamber 30. 62 is a butterfly valve in this pipe controlled by a lever 63, quadrant 64 and adjusting screw 65. 66 is a float cylinder immersed in the water

box 60 into which the pipe 61 discharges. 67 is a connecting rod for the float 66 extending up through a cover 68 to a lever 69 which lever is pivoted on the housing. 70 is a weight adjustable on the lever adapted to be locked in position by the set screw 71 to adjust the response of the lever. 72 is a filler plug for the water chamber. 73 is a link anchored on the housing at one end and pivoted at the other end in any one of a plurality of adjusting holes 74 on the lever 69. 75 is a turn buckle adapted to adjust the length of this link. The link contains intermediate its ends a housing 76 in which is a spring 77 which tends to yieldingly resist movement of the lever in response to the up and down movement of the float chamber. The change in pressure within the plenum chamber tends to change the position of the float lever. This spring and weight tend to damp out any vibratory effect on the float chamber which would result from the pulsating air current fed into the plenum chamber and make changes in position of the lever responsive only to general changes in pressure in the plenum chamber caused by changes in the resistance offered to the discharge of the air current through the bed of material on the deck.

80 is a coal chute, 81 a middlings chute and 82 a refuse chute. The coal and middlings chutes are presented to the stream of material as it travels down the deck above the floor of the deck. The refuse chute is fixed and catches the refuse which travels along the bottom of the stream and leaves the deck beneath the middlings chute. The coal and middlings chutes are manually adjustable by means of levers 83 and lock screws 84. Gates 85 and 86, in pivoted relationship to the middlings chute 81 and the refuse chute 82 control the rate of flow through these chutes, the rate of flow over the coal chute needing no adjustment. These gates are mounted on shafts 87 having levers 88 and links 89 pivoted at their upper ends on the lever 69. These links are adjustable as regards the points at which they are attached to levers 88 and the main lever 69. They are also provided with turn buckles as indicated to control their length and the levers are provided with counterweights to balance the weight on the gates. The gates 85 and 86 are controlled automatically responsive to the variation in pressure in the plenum chamber which is brought about by changes in the thickness and resistance to flow of the mass of material traveling along the deck.

For instance, if the refuse is not escaping as rapidly as it should, it will build up, resist air flow and pressure will build up then in the plenum chamber and the refuse gate will be opened wider, thus drawing off more refuse. The same thing applies to the middlings. As soon as an excess of middlings or refuse is drawn off then the pressure will decrease in the plenum chamber and the gate will return to its initial position or will even close farther if that is necessary to compensate for the operation of the device.

101 is a supporting grid contained within the bed of coal supported by links 102 reciprocated by a connecting rod 103 connected to the feeder plate. A turn buckle and a plurality of pivot holes are provided to adjust the response to this grid to the reciprocation of the feeder plate. The grid is made up of coarse wires or a plate with coarse perforations so that it does not have any screening effect whatever on the coal. It merely tends to agitate and to some extent support the coal and tends to guide the refuse along parallel lines along the floor beneath the stream of material. Under some circumstances, the drive mechanism for the star wheel will be connected to this stirring grid instead of being directly connected to the reciprocating feeder plate.

Experience shows that especially when dealing with material wherein the heavy refuse is found in both large and small sizes, the response of this refuse to the same air blast is different. Coarse refuse will sink to the bottom when the blast is strong, but fine refuse will be buoyed up by the air and even though it is heavier than the coal will be floated on the top. On the other hand if the air blast is weak, the fine heavy material reports to the bottom of the bed whereas the coarse heavy material will be squeezed out by the fine material and forced away from the bottom. Thus two kinds of blast are required to handle some of the heavy material though this is not true of the coal or of the material only a little heavier than the coal. It is to take care of this situation that the central discharge gate and chute is used. As indicated the air blast is at a maximum intensity through the upstream end of the bed and the result is that the heavy coarse material reports to the bottom and is drawn off through the chute. Then because of the interposition of the breeches chute obstructing the plenum chamber and the adjustable gate or valve associated with it, the pressure is lower in that part of the plenum chamber below the downstream end of the deck and so that fine very heavy material now reports to the bottom of the deck and is discharged through the end of the refuse chute.

It will be understood that it is essential that the central gate and its chute be full of material at all times. In other words, it will not do to draw material off through this intermediate refuse gate at too high a rate of speed and experience shows that all that is necessary is to provide a manual adjustment, the operator being familiar with the character of the coal being treated and being able to see what is coming out of the chute can make a manual adjustment which will be sufficient for operation. The automatic adjustment is needed in connection with the middlings and the finally discharged refuse only.

It will be understood that although the various mechanisms used to connect up operating elements are suitable and satisfactory they might be different. Separate drives might be used for the star wheel, the pulsator, the feeder and the like. Different types of connections might be used to transmit the force of the pulsating air current in the plenum chamber to the gates and chutes and it will be understood, therefore that my invention as shown is more or less diagrammatic and a wide range of mechanical equivalents both in drive, in control and in arrangement might be used.

In order to insure that only pure refuse will be withdrawn through the discharge port 13, I provide on the downstream side of that port a dam 131. The supporting grid 101 is upwardly bowed or curved above this dam at 132 so as to maintain between the top of the dam and the grid or plate substantially the same clearance as is maintained between the grid and the floor 9. It will be understood that the refuse accumulates behind this dam, there being a concentration of pure refuse on the upstream side from which the refuse dis-

charged through the chute or port 13 comes. The dam will permit excess refuse and coal to pass over it and will not interfere with the support of material on the downstream side.

In the modified form shown in Figure 5, there is substituted for the gate 86 controlled by variations in pressure in the air box a star wheel 150 driven by link 151 pivoted at one end on the link 20 and at the other end on a lever 152 having a dog 153 engaging the ratchet wheel 155. The lever 152 is provided with a plurality of holes so that the lever arm through which the link works may be adjusted to control the rate of discharge of the refuse from the discharge end of the bed. Preferably the height of the blade 80 controlling the bottom of the zone from which coal is discharged and the blade 81 controlling the bottom of the zone from which middlings are discharged will as before be manually adjusted once and for all during the operation of the device, although under some circumstances it might be possible and desirable to use a star wheel as a substitute for the gate 85 also. Under ordinary circumstances, it is sufficient to mechanically control the rate of flow of the refuse alone because the refuse is discharged as a finished product and it is important that only refuse be discharged, coal not being discharged with it. The middlings can have varying amounts of coal because under ordinary conditions the middlings are returned for reworking to the system or are treated on a separate deck and if the star wheel is used to control the refuse, the middlings may be uncontrolled or may be controlled in response to variation in pressure.

I claim:

1. A material classifying device comprising a pervious fixed inclined floor, means for feeding a relatively deep stream of material to be classified downwardly therealong, a resistance bed beneath and coextensive with the floor, a discharge port extending entirely across the floor intermediate its ends, means for discharging a pulsating current of air upwardly through the stream of material, a plate having a relatively large number of apertures substantially larger than the size of the material particles being treated suspended in the stream of material above and generally parallel with the floor, said plate having a raised portion directly above said discharge port, and means for imparting to said plate a reciprocatory movement in general parallelism with the plane thereof.

2. A material classifying device compring a pervious fixed inclined floor, means for feeding a relatively deep stream of material to be classified downwardly therealong, a resistance bed beneath and coextensive with the floor, a discharge port extending entirely across the floor intermediate its ends, means for discharging a pulsating current of air upwardly through the stream of material, a plate having a relatively large number of apertures substantially larger than the size of the material particles being treated suspended in the stream of material above and generally parallel with the floor, means for imparting to said plate a reciprocatory movement in general parallelism with the plane thereof, a star wheel adapted to control the rate of flow of material through the port, and driving means for rotating said star wheel in consonance with the reciprocation of the plate.

3. A material classifying device comprising a pervious fixed inclined floor, means for feeding a relatively deep stream of material to be classified downwardly therealong, a resistance bed beneath and coextensive with the floor, a discharge port extending entirely across the floor intermediate its ends, means for discharging a pulsating current of air upwardly through the stream of material, a plate having a relatively large number of apertures substantially larger than the size of the material particles being treated suspended in the stream of material above and generally parallel with the floor, means for imparting to said plate a reciprocatory movement in general parallelism with the plane thereof, a star wheel adapted to control the rate of flow of material through the port, driving means for rotating said star wheel in consonance with the reciprocation of the plate, and means for adjusting the angular distance the star wheel rotates responsive to each reciprocation of the plate.

4. A material classifying device comprising a pervious fixed inclined floor, means for feeding a relatively deep stream of material to be classified downwardly therealong, a resistance bed beneath and coextensive with the floor, a discharge port extending entirely across the floor intermediate its ends, a dam projecting upwardly from the floor in alignment with downstream side of the discharge port, means for discharging a pulsating current of air upwardly through the stream of material, a plate having a relatively large number of apertures substantially larger than the size of the material particles being treated suspended in the stream of material above and generally parallel with the floor, the plate being bowed upwardly immediately adjacent the dam, and means for imparting to said plate a reciprocatory movement in general parallelism with the plane thereof.

5. A material classifying device comprising a pervious fixed inclined floor, means for feeding a relatively deep stream of material to be classified downwardly therealong, a resistance bed beneath and coextensive with the floor, a discharge port extending entirely across the floor intermediate its ends, a dam projecting upwardly from the floor in alignment with the downstream side of the discharge port, means for discharging a pulsating current of air upwardly through the stream of material, a plate having a relatively large number of apertures substantially larger than the size of the material particles being treated suspended in the stream of material above and generally parallel with the floor, the plate being bowed upwardly immediately adjacent the dam, and means for imparting to said plate a reciprocatory movement in general parallelism with the plane thereof, the clearance between the plate and the dam being substantially the same as between the plate and the inclined floor.

6. The process of separating impurities from coal which consists in forming a continuous uniformly inclined bed of crude coal, said bed being of uniform width from end to end, causing the coal in said bed to flow lengthwise thereof by forcing pulsating currents of air upward through the bed, continuously adding crude coal to the upper end of said bed, utilizing the greater specific gravity of the impurities to bring about progressive stratification of the flowing coal and impurities, modifying the stratification step by employing air currents of greater intensity at the upper end of the bed than at the lower end, whereby only the coarser impurities separate

from the coal in the upper portion of the bed, withdrawing the bulk of said coarser impurities from the bottom of the bed in a single downwardly descending stream coming from all portions of the bed on a transverse line at the lower margin of the zone of high intensity air currents, and withdrawing the remainder of the coarser impurities from the lower end of the bed separate from and underneath the fine impurities which separate in the zone of low intensity air currents.

7. A material classifying device comprising an air pervious fixed inclined floor, means for feeding material to the upper end of said floor, a resistance bed beneath and coextensive with said floor, an air chamber beneath and coextensive with said resistance bed, means for discharging a pulsating current of air into said air chamber adjacent the feed end of the floor, whereby currents of air are forced upward through said resistance bed to cause said material to flow downwardly along said floor and separate into different layers, a discharge chute for the lower layer extending down through said resistance bed and entirely across the floor intermediate its ends, an extension of said chute passing through a portion of said air chamber, and a movable shutter cooperating with said extension to form an adjustable partition across said air chamber whereby the air currents forced through the lower section of said resistance bed may diminish in intensity.

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